We claim:

1. A method of operating an internal combustion diesel engine comprising:

taking into a combustion chamber of an internal combustion diesel engine a mixture of air and recirculated exhaust gas, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is below 16%;

injecting fuel into said combustion chamber at a fuel injection pressure exceeding 1800 bar; and

combusting said fuel in said combustion chamber with said mixture of air and recirculated exhaust gas, thereby producing useful work and a new quantity of exhaust gas, said new quantity of gas containing a level of nitrogen oxides (NOx) less than 1.0 gram per horsepower-hour of work performed by the engine.

2. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is below 15%.

3. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is below 14%.

4. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is maintained between 10% and 15% for medium and high loads.

5. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is maintained between 11% and 14% for medium and high loads.

6. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is maintained between 12% and 13.5% for medium and high loads.

7. The method of claim 1, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is maintained relatively constant from cycle to cycle.

8. The method of claim 1, wherein an EGR ratio and the oxygen concentration of the exhaust gas are maintained relatively constant from cycle to cycle.

9. The method of claim 1, wherein the mixture of air and recirculated exhaust gas comprises an EGR level of greater than 40% at medium or high loads.

10. The method of claim 1, wherein the mixture of air and recirculated exhaust gas comprises an EGR level of greater than 50% at medium or high loads.

11. The method of claim 1, wherein said fuel is injected into said combustion chamber at a fuel injection pressure that meets or exceeds 2000 bar.

12. The method of claim 1, wherein said fuel is injected into said combustion chamber at a fuel injection pressure that meets or exceeds 2100 bar.

13. The method of claim 1, wherein said fuel is injected into said combustion chamber at a fuel injection pressure that meets or exceeds 2300 bar.

14. The method of claim 1, wherein said fuel is injected into said combustion chamber at a fuel injection pressure that meets or exceeds 2500 bar.

15. The method of claim 1, wherein said fuel is injected into said combustion chamber at a fuel injection pressure that meets or exceeds 3000 bar.

16. The method of claim 1, wherein said new quantity of exhaust gas contains a level of nitrogen oxides (NOx) less than or equal to 0.5 grams per horsepower-hour of work performed by the engine.

17. The method of claim 1, wherein said new quantity of exhaust gas contains a level of nitrogen oxides (NOx) less than or equal to 0.2 grams per horsepower-hour of work performed by the engine.

18. The method of claim 1, wherein the level of nitrogen oxides (NOx) are maintained equal to or below 0.2 grams per horsepower-hour of work performed by the engine at substantially all engine speeds and loads.

19. The method of claim 1, wherein said new quantity of exhaust gas has a smoke content at or below a Bosch Smoke Number of 3 before or without aftertreatment.

20. The method of claim 1, wherein said new quantity of exhaust gas has a smoke content at or below an average Bosch Smoke Number of 1.5 before or without aftertreatment.

21. The method of claim 18, wherein said new quantity of exhaust gas also has a smoke content at or below a Bosch Smoke Number of 3 before or without aftertreatment at substantially all engine speeds and loads.

22. The method of claim 1, wherein said useful work is produced at greater than 30% thermal efficiency at substantially all normal engine speeds and loads.

23. The method of claim 1, further comprising providing sufficient intake system pressure to assure sufficient oxygen for combustion of said fuel.

24. The method of claim 1, further comprising compressing the air or recirculated exhaust gas before intake into the combustion chamber such that the ratio between the mass of the mixture of air and recirculated exhaust gas and the mass of the injected fuel is between 25:1 and 45:1 for operation of the engine at medium or high loads.

25. The method of claim 1, further comprising: taking into the combustion chamber a quantity of the mixture of air and recirculated exhaust gas that is greater than that needed for stoichiometry with the fuel injected into the combustion chamber, thereby providing sufficient excess oxygen in the combustion chamber to facilitate substantial completeness of combustion and to create exhaust products with sufficient oxygen for regeneration of a particulate trap.

26. The method of claim 25, further comprising: continuously providing the combustion chamber with a predetermined amount of excess oxygen to maintain exhaust oxygen levels sufficient for continuous particulate trap regeneration at a balance point during operation of the engine.

27. A method of operating an internal combustion diesel engine comprising:

taking into a combustion chamber of an internal combustion diesel engine a mixture of air and recirculated exhaust gas, wherein the oxygen concentration of said mixture of air and recirculated exhaust gas is between 11% and 14%;

injecting fuel into said combustion chamber at a fuel injection pressure exceeding 2000 bar; and

combusting said fuel in said combustion chamber with said mixture of air and recirculated exhaust gas, thereby producing useful work and a new quantity of exhaust gas, said new quantity of gas including a level of nitrogen oxides (NOx) equal to or less than 0.2 grams per horsepower-hour of work performed by the engine and a smoke content at or below a Bosch Smoke Number of 3.

28. An internal combustion engine system comprising:

one or more cylinders, each cylinder providing a combustion chamber;

one or more fuel injectors in communication with said cylinder(s), capable of injecting fuel into each said combustion chamber at fuel injection pressures exceeding 1800 bar;

an air intake line operatively connected to the cylinder(s), to provide air to the combustion chamber(s);

an exhaust line also operatively connected to the cylinder(s), to receive exhaust gas from the combustion chamber(s), and including means for recirculation of a portion of said exhaust gas to said air intake line;

means for combining recirculated exhaust gas with ambient air in said air intake line;

an EGR control valve operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a value below 16%;

one or more compressors operatively connected to the air intake line, to pressurize said recirculated exhaust gas and/or ambient air before their entry into said combustion chamber(s); and

a controller programmed to control the quantity of fuel injected in relation to the extent of pressurization of said recirculated exhaust gas or ambient air taken into the combustion chamber so as to maintain the level of nitrogen oxides (NOx) in the exhaust gas equal to or below 1.0 gram per horsepower-hour.

29. The internal combustion engine system of claim 28, wherein the EGR control valve is operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a value below 15%.

30. The internal combustion engine system of claim 28, wherein the EGR control valve is operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a value below 14%.

31. The internal combustion engine system of claim 28, wherein the EGR control valve is operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a value between 12% and 13.5%.

32. The internal combustion engine system of claim 28, wherein the EGR control valve is operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a predetermined relatively constant value.

33. The internal combustion engine system of claim 28, wherein said fuel injectors are capable of injecting fuel into said combustion chamber(s) at a fuel injection pressure that meets or exceeds 2000 bar independently of engine speed or load.

34. The internal combustion engine system of claim 28, wherein said fuel injectors are capable of injecting fuel into said combustion chamber(s) at a fuel injection pressure that meets or exceeds 2100 bar independently of engine speed or load.

35. The internal combustion engine system of claim 28, wherein said fuel injectors are capable of injecting fuel into said combustion chamber(s) at a fuel injection pressure that meets or exceeds 2300 bar independently of engine speed or load.

36. The internal combustion engine system of claim 28, wherein said fuel injectors are capable of injecting fuel into said combustion chamber(s) at a fuel injection pressure that meets or exceeds 2500 bar independently of engine speed or load.

37. The internal combustion engine system of claim 28, wherein said fuel injectors are capable of injecting fuel into said combustion chamber(s) at a fuel injection pressure that meets or exceeds 3000 bar.

38. The internal combustion engine system of claim 28, wherein the level of nitrogen oxides (NOx) in the exhaust gas is maintained equal to or below 0.5 grams per

horsepower-hour of work performed by the engine at substantially all engine speeds and loads.

39. The internal combustion engine system of claim 28, wherein the level of nitrogen oxides (NOx) in the exhaust gas is maintained equal to or below 0.2 grams per horsepower-hour of work performed by the engine at substantially all engine speeds and loads.

40. The internal combustion engine system of claim 28, with a smoke content level in the exhaust gas maintained at or below a Bosch Smoke Number of 3 before or without aftertreatment.

41. The internal combustion engine system of claim 28, with a smoke content level in the exhaust gas maintained at or below an average Bosch Smoke Number of 1.5 before or without aftertreatment.

42. The internal combustion engine system of claim 39, with a smoke content level in the exhaust gas also maintained at or below a Bosch Smoke Number of 3 before or without aftertreatment at substantially all engine speeds and loads.

43. The internal combustion engine system of claim 28, wherein useful work is produced at greater than 30% thermal efficiency at substantially all normal engine speeds and loads.

44. The internal combustion engine system of claim 28, wherein the controller is programmed to ensure that the combustion chamber receives a sufficient amount of excess oxygen for particulate trap regeneration.

45. The internal combustion engine system of claim 44, wherein the combustion chamber is provided with a predetermined amount of excess oxygen to maintain exhaust

oxygen levels sufficient for continuous particulate trap regeneration at a balance point during operation of the engine.

46. The internal combustion engine system of claim 28, wherein the ratio between the mass of the mixture of air and recirculated exhaust gas in the combustion chamber and the mass of the injected fuel is between 25:1 and 45:1 for operation of the engine at medium or high loads.

47. The internal combustion engine system of claim 28, wherein the amount of the mixture of air and recirculated exhaust gas taken into the combustion chamber is greater than that needed for stoichiometry with the fuel injected into the combustion chamber, thereby providing sufficient excess oxygen to facilitate substantial completeness of combustion and to create exhaust products with an oxygen concentration sufficient for regeneration of a particulate trap.

48. The internal combustion engine system of claim 28, further comprising a low pressure EGR loop for recirculation of the exhaust gas.

49. An internal combustion engine system comprising:

one or more cylinders, each cylinder providing a combustion chamber;

one or more fuel injectors in communication with said cylinder(s), capable of injecting fuel into each said combustion chamber at fuel injection pressures exceeding 2000 bar;

an air intake line operatively connected to the cylinder(s), to provide air to the combustion chamber(s);

an exhaust line also operatively connected to the cylinder(s), to receive exhaust gas from the combustion chamber(s), and including means for recirculation of a portion of said exhaust gas to said air intake line;

means for combining recirculated exhaust gas with ambient air in said air intake line;

an EGR control valve operated so as to control the oxygen concentration of the combined recirculated exhaust gas and ambient air to a value between 11% and 14%;

one or more compressors operatively connected to the air intake line, to pressurize said recirculated exhaust gas and/or ambient air before their entry into said combustion chamber(s); and

a controller programmed to control the quantity of fuel injected in relation to the extent of pressurization of said recirculated exhaust gas or ambient air taken into the combustion chamber so as to maintain the level of nitrogen oxides (NOx) in the exhaust gas equal to or below 0.2 grams per horsepower-hour.

50. The internal combustion engine system of claim 49, with a smoke content level in the exhaust gas maintained at or below a Bosch Smoke Number of 3 before or without aftertreatment.

51. A method of reducing formation of nitrogen oxides (NOx) in an internal combustion diesel engine, comprising controlling the oxygen concentration of air used in combustion in the diesel engine to stay between 10% and 15% for medium and high loads.

52. The method of claim 51, further comprising controlling the oxygen concentration of air used in combustion to stay between 11% and 14% for medium and high loads.

53. The method of claim 51, further comprising controlling the oxygen concentration of air used in combustion to stay between 12% and 13.5% for medium and high loads.

54. The method of claim 51, wherein the oxygen concentration of air used in combustion is controlled to a predetermined relatively constant value in part through

maintaining the oxygen concentration of recirculated exhaust gas to a predetermined relatively constant value.

55. The method of claim 51, further comprising maintaining nitrogen oxides (NOx) in the exhaust of said engine equal or below 0.2 grams per horsepower-hour of work performed by said engine.